

130G-1

## PLUMBING AND PIPE FITTING

130-G

### UNIT OBJECTIVE

After completion of this unit, students will be able to properly identify plumbing materials, perform plumbing installations, and exhibit safe handling and working practices with plumbing tools and equipment. This knowledge will be demonstrated by completion of assignment sheets and a unit test with a minimum of 85 percent accuracy.

### SPECIFIC OBJECTIVES AND COMPETENCIES

After completion of this unit, the student should be able to:

1. Properly identify plumbing materials.
2. Understand the purposes for the various plumbing materials.
3. Understand the purposes for the various plumbing fittings and materials.
4. Properly identify plumbing tools and materials.
5. Perform an installation, including cutting pipe to length and installing fittings, using a combination of materials, including steel, plastic, and copper.
6. Exhibit safe handling and working practices with plumbing tools.

## PLUMBING MATERIALS

A. Plumbing systems supply water and take away wastes by routing pipes to and from fixtures or appliances. Plumbing is a two-part system:

1. The water supply system carries fresh (potable) water from a source such as a well or street main to a fixture.
2. The Drain-Waste-Vent (DWV) system carries excess water and waste away to a septic system or municipal waste treatment center.
3. Plumbers and pipefitters are people who install and repair plumbing systems.
4. The Uniform Plumbing Code (as well as local plumbing codes) should be followed when installing pipes, fittings, and fixtures in order to provide a safe operating system.
5. In agriculture, many liquids in addition to water (e.g., milk, soybean oil) are carried through specially designed pipes to points of storage and processing.

B. Plumbing the Home and Farmstead

1. Designing a plumbing system for the home and/or farmstead requires a knowledge of and familiarity with plumbing materials.
  - a. A pipe is any rigid tube like material.
  - b. Tubing is any pipe that is flexible enough to bend.
  - c. A nipple is a short pipe under 12 inches in length.
  - d. A fitting is a connecting device used to join pieces of pipe or to connect pipe to other objects such as fixtures, appliances, or pumps.
  - e. The size of pipe is generally based on the inside diameter (ID) which is a nominal size, not the actual size. However, the outside diameter (OD) may occasionally be used to measure the size of the pipe.
2. In agricultural mechanics, most work completed with pipe and pipe fittings may be considered to be a part of plumbing.

C. Material Identification in Plumbing Construction Pipes

1. Steel pipe is available in three grades: standard (sch 40, wall thickness in inches), extra strong (sch 80), and double extra strong (sch 120).
  - a. Extra strong (sch 80) and double extra strong (sch 120) are used primarily in commercial and industrial settings.

- b. All grades of steel pipe have the same outside diameter for a given size which permits pipe threading with the same die; it also allows the use of the same sized pipe fittings for all three pipe grades. The additional wall thickness results in reduced inside diameters.
2. Two types of steel pipe are primarily used in plumbing: black iron and galvanized steel. (**Show Examples** if you have any)
- a. Black iron pipe is used for gas, steam, and emergency fire systems.
  - b. Black iron pipe has no coating; therefore it provides little resistance to rust. When used for underground gas lines, black iron pipe comes with a Poly-Vinyl-Chloride (PVC) coating to protect it from corrosion.
  - c. Before 1970, galvanized pipe was used mainly for water supply and cold water systems. It is still used in combination with other materials because of its strength and ability to support cantilevered weight (such as hand rails and bike racks).
  - d. Galvanized pipe will meet the minimum pressure requirement of 125 psi when standard (sch 40) is used.
  - e. Galvanized pipe not only creates greater friction losses than copper and plastic pipes do, but it also has a greater tendency to scale and thus it reduces flow capacity.
  - f. Galvanized pipe lasts at least 30 years in most soils, where as black pipe would last less than 10 years.
3. Connecting steel pipe in plumbing construction requires two types of fittings: threaded and dielectric fittings.
- a. Threaded fittings are tapered threads which create an interference fit that should not be used in combination with other threads such as machine or hose threads.
    - 1) Threaded fittings are extremely time consuming to make.
    - 2) Threaded fittings require some type of pipe thread compound such as pipe joint compound or Teflon tape to create a water tight seal.
  - b. Dielectric (nonconducting) fittings (couplings or bushings) are necessary when dissimilar pipes are used in combination with copper pipe or tubing in order to minimize electrolysis (dissimilar metals causing a chemical reaction) which causes corrosion.

4. Additional Standard Information Regarding Steel Pipe

- a. The standard length of steel pipe is 21 feet.
- b. Steel pipe is sized according to the nominal ID.
- c. Steel pipe is the best material for resisting mechanical or fire damage.
- d. Water quality should be considered before selecting pipe materials. Investigate the local plumbing code.
- e. Galvanized pipe nipples can be purchased in half-inch increments up to 6 inches and 1-inch increments from 7 to 12 inches.

5. Copper pipe is available in two types: rigid pipe and flexible tubing. It is used in water supply and Drainage-Waste-Vent (DWV) systems. (**Show Examples** if you have any)

- a. Rigid copper pipe is available in four wall thicknesses and is color coded.
  - 1) Thin-walled (type M-red) is usually adequate for home plumbing.
  - 2) Medium-walled (type L-blue) is generally used for commercial plumbing.
  - 3) Thick-walled (type K-green) is used on outside work that may be subject to mechanical damage or for underground burial.
  - 4) Drainage-Waste-Vent (DWV-yellow) may be used in any DWV system. This is the thinnest-walled form of copper pipe.

b. Additional Information Regarding Rigid Copper Pipe

- 1) Rigid copper pipe diameter is measured by the nominal ID.
- 2) The OD is a given nominal size which remains the same for all four weights of pipe.
- 3) Rigid copper pipe is sold in standard 10 and 20 foot lengths.
- 4) Rigid copper pipe can be soldered only; it cannot be flared.
- 5) Rigid copper pipe, although comparatively expensive, is easy to work with in both new installations and modified systems. The savings in labor will generally offset the high cost of materials.

c. Flexible copper tubing, unlike rigid copper pipe as described above, is not color coded. However, it is graded according to two types of wall thicknesses and is marked every eighteen inches with its type and manufacturing information.

- 1) Medium-walled (type L) is used in most homes, principally for gas service lines.
- 2) Thick-walled (type K) is used in most homes for underground water service lines.
- 3) There is no thin-walled or DWV type of flexible copper tubing.
- 4) The chief advantage of flexible copper tubing is its flexibility; it can easily be bent across the knee. However, care must be taken to avoid kinking.
- 5) Flexible copper tubing is resistant to most corrosion.

6. Plastic pipe, similar to copper pipe, is available in two types: rigid pipe and flexible tubing.

a. Rigid pipe is manufactured out of three different synthetic products: PVC, ABS, and CPVC. (**Show Examples** if you have any)

- 1) PVC (polyvinyl chloride) is used primarily for cold water supply, DWV, and irrigation lines.
- 2) ABS (acrylonitrile butadiene styrene) is used exclusively for DWV systems.
- 3) CPVC (chlorinated polyvinyl chloride) is used in hot and cold water supply. Although it costs three to four times more than pvc it normally is used because it withstands heat and maintains its strength. The local plumbing code should be checked prior to CPVC installation.

b. Plastic rigid pipe is available in three weights: schedule 40, 60, and 80; all weights meet the minimum pressure rating of a closed water system. (Other lighter weight [ie. class 125] pipe is also available, but it should be used only for landscape irrigation purposes.)

c. Additional Information Regarding Rigid Plastic Pipe

- 1) Rigid plastic pipe is sized according to its nominal ID.
- 2) Rigid plastic pipe is available in standard 20 feet lengths.
- 3) The OD remains constant while the ID varies according to weight; this allows the use of the same fittings.

- 4) All types of rigid plastic pipe can be joined to their respective fittings by using an appropriate solvent cement (solvent-welded) for the job. Time and temperature play an important role in getting a good seal.
- 5) Local codes generally forbid the use of rigid plastic pipe behind or within walls. Sch 80 is recommended for out-of-ground exposed work.

d. Flexible plastic tubing is available in only two types of synthetic material: PE (polyethylene), commonly used in landscape drip irrigation, and PB (poly-butylene), a relatively new material used indoors for hot and cold water supply systems.

e. Additional Important Information Regarding Flexible Plastic Tubing

- 1) The inside diameter of flexible plastic tubing remains constant while the outside diameter varies according to the quality.
- 2) Flexible PE tubing can be used only for outside cold water systems such as wells or sprinklers.
- 3) Flexible plastic tubing is connected to itself or steel pipe by using polystyrene fittings and couplings. Stainless steel base clamps are used to secure the slip joints. Solvent is not used.
- 4) There are several advantages to working with flexible plastic tubing: low material cost, ease and speed to work with, and flexibility.
- 5) Flexible plastic tubing does not normally corrode; however, it will deteriorate with extended exposure to direct sunlight. If it is not exposed to direct sunlight, flexible plastic tubing has a long life expectancy.
- 6) Flexible plastic tubing creates less friction loss than metal pipes do.

#### D. Identification of Miscellaneous Material Used in Plumbing Construction:

1. Steel pipe requires the application of a sealant to ensure a leakproof fit.
  - a. Pipe thread compound, which commonly contains Teflon, is used on the threads of pipes to prevent leaks.
  - b. Teflon tape can be used as an alternative to pipe thread compound.

2. Solder is the medium used to join copper pipe and fittings.
  - a. Solder comes in a variety of types. 50-50 solder is a combination of 50% tin and 50% lead and is suitable for moderate temperature and pressure. If a stronger joint is required, 95-5 solder (which is 95% tin and 5% antimony,) may be used.
  - b. 50-50 solder is no longer allowed for use in water supply systems because of its lead content. Therefore, check the local plumbing code, and use a lead-free solder such as 95-5 where appropriate.
  - c. Flux is necessary to remove oxides, promote wetting, and protect surfaces during heating. It should not be relied upon to clean the surfaces of copper pipe and fittings. Manual cleaning is required.
3. Plastic pipes and fittings are joined by a solvent weld joint.
  - a. Primer is essential for a solvent weld joint in plastic pipe. Priming cleans the surface, removes glaze, and starts the softening process to make a proper joint. Use the appropriate primer for the type of plastic pipe being used.
  - b. Solvent glues or cements are available for ABS, PVC, CPVC plastic pipe. Use the appropriate type for the pipe being used. All purpose or universal solvent glues are convenient to use when using more than one type of plastic pipe.

---

ACTIVITY:

1. Take a short tour of the school grounds and identify the types of plumbing materials found.
2. Visit an agricultural enterprise and observe the types of plumbing materials used for supplying water and carrying away various wastes.
3. Find exposed plumbing at home and identify the types of material used by application.

## FITTING

- A. Plumbing fittings have different shapes which allow rigid straight pipe to change both direction and diameter. Since the names of plumbing fittings derive from either their shape or their function, the names remain the same regardless of the material from which they are made. Fittings are generally divided into two categories: water supply or DWV. A description of the most common plumbing fittings follows:
1. Elbows are used to change the angle or direction of the pipe run. The most common elbows come in 90 degree and 45 degree turns. The sweep of the fitting describes how fast a transition or change in direction is made. Therefore--especially in DWV fittings--the long sweep fittings are chosen to avoid clogs. 90 degree elbows are generally called ells.
  2. On street elbows, one end of the fitting has male threads and the other end has female threads. Street elbows are common in galvanized steel and copper pipe. They are convenient because they do away with the need for a nipple and work well in tight quarters.
  3. Tee or T-fittings allow for branch lines. They are shaped like the letter T. DWV tees are known as waste or sanitary Ts. In these fittings the intersection is slightly curved in order to avoid clogs. Gradual bends are best for smooth flow of waste.
  4. Couplings are used to join two straight pieces of pipe of the same diameter.
  5. Reducers are used to join pipe of different diameters. Galvanized steel reducers are called bell reducers because they look like a bell. All reducers make a gradual transition between different diameters of pipe and therefore they take up considerable space.
  6. Bushings are used to make the diameter of a pipe fitting smaller. They differ from reducers in that they make abrupt changes in diameter and take very little space. Two examples of galvanized steel bushings are face bushings, which take the least amount of space, and hex bushings which can be tightened with an adjustable wrench.
  7. Unions are used to join pieces of pipe where pipes cannot be turned or when a piece of equipment may have to be removed for maintenance or replacement.
  8. Adapter fittings are used to change the end of a non-threaded pipe to male or female threads as needed. Adapters are commonly used in copper and plastic plumbing jobs.
  9. Caps are used to close the end of a dead end pipe.
  10. Plugs close an opening on a pipe fitting normally used for inspection and clean out.



11. Nipples are short lengths (under 12") of pipe threaded at both ends.
12. Wyes (pronounced like the letter Y) are used primarily to gain inside access to DWV systems.

B. Valves and Hose Bibs - Valves are used to control the flow of water or other fluids in a plumbing system. Common types of valves include the following:

1. A gate valve is a valve situated between the point of connection and the rest of the plumbing system.
  - a. It usually remains wide open, but can be shut down in case repairs or additions have to be made to the system.
  - b. A gate valve is not designed to be opened and closed on a regular basis. It has a movable wedge that is turned via a handle and spindle to regulate the size of the opening.
  - c. Repairs are simple. Remove the handle and packing nut and replace the packing washer. Reassemble and install. Remember to check for leaks. Do not overtighten the packing nut.
2. A check valve allows the fluid in the pipe to flow in one direction only.
  - a. Check valves are used in water wells to prevent the backflow of water.
  - b. There are two basic types: swing or flapper and lift check valves. Both work automatically.
3. A globe valve is a valve used when frequent adjustment of the flow rate is necessary.
  - a. It is a compression-type valve with a disk or washer that is compressed into a seat to form a tight seal.
  - b. Repair is made by replacing the stem washer or disk.
4. A hose bib is a threaded exterior faucet that allows for the attachment of a garden hose or appliance hose. It can also be called a sillcock or hosecock.

---

ACTIVITY:

1. Make a collection of pipe fittings for a display board.  
Use steel, copper, and plastic examples.
2. Disassemble and compare a gate valve and a globe valve.
3. Repair a leaking hose bib.

## PLUMBING TOOLS

Many different kinds of tools are used in plumbing. Steel, copper, and plastic are the most common plumbing pipe materials. Common and specialized tools needed to safely and efficiently work with plumbing materials are described below.

### A. Measurement and Layout Tools

1. Steel tapes come in a variety of lengths; the ones most commonly used in plumbing are 50 and 100 feet long.
2. A tape measure has a retractable steel blade and comes in 8, 10, 12, 16, and 25 foot lengths.

### B. Benches and Vises

1. A pipe vise is the preferred tool to use to hold steel pipe in place for cutting, reaming, and threading. It can be mounted on a portable tripod stand for field use.

NOTE: A machinist's vise should not be used to secure pipe unless it has a set of pipe jaws in addition to the regular jaws. Trying to hold round pipes in the straight-edged jaws of a machinist's vise can lead to slippage of the pipe if the jaws are secured too loosely and flattening of the pipe if the jaws are secured too tightly.

2. A plumber's bench is used to support large diameter steel pipe when cutting, reaming, and threading.
3. An adjustable pipe support stand has a concave roller and is used to support the free end of a long length of pipe; it is especially useful in conjunction with a portable pipe threading machine.

### C. Cutting and Threading Tools for Steel Pipe

1. A hand-held wheel-type pipe cutter is used to cut steel pipe. It is rotated around the pipe and progressively tightened. The material is pushed to either side of the cutting wheel which leaves a large ridge or burr which must be removed.
2. A pipe reamer is used to remove the ridges or burrs from the inside of pipe; it can be fluted or spiral in design.
3. A portable pipe threading machine contains a powered head and can be used to cut, ream, and thread small diameter steel pipe.
4. A half-round file is used to deburr large diameter pipe and works well on all materials.
5. Oilers are containers with a pump and nozzle used to apply cutting oil when cutting threads in steel pipe.

6. Pipe dies are used to cut threads on steel pipe. A special tapered thread commonly known as National Pipe Thread (NPT) or as American Standard Taper Pipe Thread is used to provide a leakproof joint. NPT is tapered 3/4" per foot. Since pipe fittings come threaded, the plumber needs to cut only external (male) threads on the steel pipe. Sometimes a pipe tap is used to clean up internal (female) threads on used or damaged fittings. A die stock is a handle that holds the die in place.

#### D. Cutting, Cleaning, Soldering, Flaring, and Bending Tools for Copper

1. Copper tubing cutters come in various designs for large and small diameter copper pipe and tubing. Many have a built-in reamer. Midget tubing cutters cut copper pipe in close quarters.
2. A combination inside-outside reamer is convenient for 1/4 to 1 1/2" copper tubing. It is less awkward when preparing many joints. Large diameter copper pipe may also be reamed with a half-round file.
3. Copper fitting brushes are used to clean the inside diameter of fittings. Commonly available sizes are 1/8 to 2 1/2" brushes. They are handy when doing new construction where many joints must be prepared.
4. Copper tubing brushes range in size from 1/8 to 1 inch and are used to clean the outside diameter of copper pipe. Normally copper pipe over 1 inch in diameter is cleaned with abrasive sandcloth.
5. A propane torch is commonly used for minor plumbing repairs. It is used to heat the pipe and fittings. Small throwaway cylinders make this style of torch convenient for small jobs.
6. Acetylene or propane refillable cylinders are common for large soldering jobs. A regulator, hose, and torch body make up the kit.
7. A friction igniter or striker is used to light the torches above.
8. A yoke and screw flaring tool is used when flared-style fittings join fixtures or copper tubing. After the tubing is cut and reamed, a flange nut is slipped over the tube. Then the yoke is tightened to secure the tube. The screw with its cone-shaped end is tightened to produce a 45 degree flared end.
9. A swage (swedge) or hammer-type flaring tool can be used to flare soft copper tubing. They come in diameters ranging from 1/4" to 1."
10. A spring bender is used to bend soft-tempered copper with outside diameters ranging from 1/4 inch to 7/8 inch.
11. A lever-type bender is used to bend small diameter (3/16 inch to 1/2 inch) copper tubing.
12. Pipe benders come in various designs and sizes and can be used on large-diameter (5/8 to 7/8 inch outside) hard drawn copper tubing.

#### E. Cutting and Reaming Tools for Plastic Pipe

1. A plastic tubing cutter is used to cut Poly-Ethylene (PE) or Poly-Butylene (PB). It operates like a pair of shears.
2. Tubing cutters are primarily designed for copper, but they also work well with plastic.
3. A blade-type cutter works similar to a tubing cutter, but uses a replaceable blade rather than a cutting wheel.
4. Hacksaws have replaceable blades and work well for cutting small diameter (2" or less) plastic pipe as long as care is taken to make a square cut.
5. Plastic pipe inside-outside reamers come in various sizes. A pocket knife or half-round file works equally well for deburring plastic pipe.

#### F. Assembly Tools - Wrenches and pliers are used to tighten fittings and turn pipe. Finishing assembly tools have smooth jaws in order not to mar fixtures or decorative nuts with chrome plating. The following is a partial list:

1. Straight pipe wrenches come in a variety of sizes and materials. Aluminum is popular and reduces fatigue because it is 40 percent lighter than malleable cast iron pipe wrenches.
2. End pipe wrenches are used in tight locations. They also come in a variety of sizes.
3. Chain wrenches and chain tongs are used to tighten iron and steel pipe. They distribute the biting force evenly around the pipe without crushing it and can be used in close quarters.
4. Monkey wrenches come with smooth jaws and are used to tighten square and hexagonal fittings.
5. Adjustable open-end wrenches (also known as crescent wrenches) have smooth jaws and can be used in finish work.
6. Multi-joint pliers (also known as water pump or channel lock pliers) are used with plastic pipe and for a variety of other applications.

#### G. Miscellaneous Plumbing Tools

1. A plunger clears drain clogs with air pressure and water.
2. A snake is a flexible steel cable rotated and pushed through a pipe to unseat a clog.
3. A jab saw is used to cut off water closet bolts; it can be useful in tight spots where a hacksaw would be handy.
4. A basin wrench is used to extend behind fixtures and tighten water supply connections.
5. A basket-strainer wrench is a specialized wrench used to tighten the basket strainer in a kitchen sink.

Activities:

1. Set out plumbing tools and materials and have students identify them, checking to be sure they use the correct names.
2. Choose the appropriate tools to use with each type of pipe and then practice cutting, reaming, threading various sizes of steel, copper, and plastic pipes.

## INSTALLATION OF A PLUMBING PROJECT

### \*SAFETY IN PLUMBING WORK\*

Observe the following general safety practices in doing all plumbing work.

1. Be sure the system is not electrically charged. If a hot or shorted wire is touching any part of the metal plumbing system, the shock can kill anyone who touches it. Thawing frozen water pipes with an arc welder can create shock as well.
2. Wear safety glasses. When plumbing, protect your eyes.
3. Wear hard hat and safety shoes. These protect against blows from heavy objects, bursting pipes, and solvents which are used for soldering plastic pipe.
4. Cut off water pressure. Do this before repairing or adjusting the system.
5. Use a pipe vise. This is the safe way to hold pipe for threading.
6. Guard against burns. When using propane or butane torches for soldering, be careful not to burn yourself or the structure you are plumbing.
7. Guard against fire. In addition to being flammable, some plastic pipe soldering solvents are highly toxic and injurious to the skin.
8. Be careful when installing copper tubing in older buildings. When reworking the plumbing system in an existing structure, be careful not to touch hot electrical wires. If you are unaware of the presence of electrical service in the wall switch, turn the circuit breaker off until you have installed the copper pipe

\* Reprinted by permission of Interstate Publishers, Inc., from MODERN AGRICULTURAL MECHANICS, 2nd ed., by Stanley R. Burke and T. J. Wakeman. Copyright 1992 by Interstate Publishers, Inc.

### A. Installing a Plumbing Project

1. A drip irrigation system is one example of a plumbing situation that uses many different types of plumbing materials.
  - a. The typical control head for commercial-scale agriculture consists of sand filters and screen filters along with regulators and backflow devices.
  - b. The control head, because of its weight, requires the strength that steel pipe offers.
  - c. The control head may be strategically positioned with unions for easy removal and maintenance.

### 2. Distribution Lines

- a. PVC is the material most commonly used for mainlines and headers.
- b. Lateral lines are often PVC or PE.

### B. General Procedures for Constructing a Plumbing Project

1. First make a working drawing for a small drip irrigation model. Then make a bill of materials and a cutting list prior to starting assembly of the system.
2. Measure and cut the various types of pipe to length.
  - a. Allow for threaded ends and fitting sockets when measuring overall length.
  - b. Use a pipe vise when cutting steel and copper pipe.
3. Ream and thread steel pipe. Ream and clean copper and plastic pipe.
4. Obtain the required fittings and clean them.
  - a. Prefit the pipe with fittings and make sure all parts are present before starting final assembly of the system.
5. Assemble the regulator, strainer, and backflow device with pipe nipples. Remember to place unions on each end.
6. Final Assembly
  - a. Lay out main line and laterals.
  - b. Use pipe joint compound for threaded fittings.
  - c. Solder any copper fittings included in the project.
  - d. Prime and glue plastic fittings.

- e. Allow the project to sit over night so the solvent weld joints (plastic) cure.
  - f. Clean up and prepare for system testing.
7. Test the project with water and check for leaks.
- a. Use a pressure gauge to measure flow pressure (dynamic) and available pressure (static).
  - b. Available pressure from the street water main or a well pressure tank generally ranges between 45-60 psi.
  - c. Never exceed 80 psi within any building.
  - d. Flow pressure for common plumbing fixtures range from 8 to 25 psi.
8. Review procedures and discuss other agricultural mechanics plumbing applications.

#### C. Specific Steps to Follow When Cutting and Threading Steel Pipe

1. Wear gloves when handling heavy pipe.
2. Measure and mark pipe.
3. Secure pipe in a pipe vise.
4. Align pipe cutter and tighten handle slightly. Rotate pipe cutter and tighten handle as needed until cut is completed.
5. Ream the inside of the pipe back to the original diameter.
6. Place the proper size die for the diameter of pipe in the die stock and thread the pipe by rotating the die. Lubricate and reverse the rotation slightly every 1/2 turn or so to break off the cutting.
7. Do not go past the end of the die housing.
8. Remove the die and wipe the thread clean.
9. Apply pipe joint compound to the male thread and start fitting by hand.
10. Complete the tightening with appropriate wrench.

#### D. Specific Steps To Follow When Cutting and Soldering Copper Pipe

1. Measure and mark the pipe.
2. Select the appropriate tubing cutter.
3. Secure pipe in pipe vise.
4. Align the cutting wheel on the mark and tighten handle slightly.
5. Rotate tubing cutter and tighten handle every 1/2-1 turn until pipe is cut.
6. Ream the inside of the pipe.
7. Clean the OD of the pipe with a tubing brush or sandcloth.
8. Clean the ID of the fitting with a fitting brush or sandcloth.
9. Wipe pieces clean.

10. Mark the pipe and fitting for its relative orientation.
11. Apply a small amount of flux over the area of contact between the pipe and the fitting. Wipe off excess flux.
12. Place the fitting in its proper relative position.
13. Light the torch and adjust the flame.
14. The approximate amount of solder to use is equal to the inside diameter of the pipe.
15. Apply heat to the tube momentarily. Allow heat to transfer to the end of the pipe. Move heat to base of fitting and place solder at the neck of the fitting. The solder will melt and be drawn into the fitting by capillary action when the temperature is correct. Do not use too much solder. It reduces the inside diameter. Do not overheat fitting.
16. Allow solder to become pasty and wipe fitting neck to remove excess solder.
17. Allow the pipe to cool.

E. Specific Steps to Follow When Cutting and Gluing Plastic Pipe

1. Measure and mark pipe for cutting and fitting orientation. A felt tip marker works well.
2. Cut pipe squarely by using a tubing cutter or miter box and saw.
3. Ream pipe by scraping ID with an inside-outside reamer or a pocket knife. Use sandcloth to clean any rough spots on the OD.
4. Check the interference fit with the fitting dry (trial run). The pipe should go in about halfway only.
5. Apply the primer to both pipe and fitting. Wait 5-15 seconds for the primer to soften and dull the finish.
6. Always apply solvent cement to the pipe and fitting.
7. Quickly insert the pipe in the fitting.
  - a. Make a 1/4 turn and align marks.
  - b. Make sure pipe bottoms out in socket.
  - c. Hold the fitting in place for 20 seconds or until the solvent begins to bond.
  - d. Check for a complete bead of cement around the fitting.
  - e. Wipe off the excess cement with a clean rag.
  - f. Allow the joint to cure for at least 30 minutes.
8. Wait overnight for the system to completely cure before testing.



ACTIVITIES:

1. Do the plumbing exercise in pipe fitting on page 130G-24,25.
2. Construct a small working model of a hog watering system with at least one gate valve and two nozzles (also known as lickets).
3. As a group, install an additional hose bibb or other necessary plumbing device at the school farm, land laboratory, or school shop.
4. Construct a small working drip irrigation model and inspect a commercial drip irrigation system.

References:

Burke, Stanley R., & Wakeman, T. J. (1990). MODERN AGRICULTURAL MECHANICS (2nd ed.). Danville, IL: Interstate Publishers.

Cooper, Elmer L. (1997). AGRICULTURAL MECHANICS: FUNDAMENTALS AND APPLICATIONS, 3ed EDITION Albany, NY: Delmar Publishers.

Editors of Reader's Digest. (1973). COMPLETE DO-IT-YOURSELF MANUAL (7th ed.). Pleasantville, NY: Reader's Digest Association.

Ripka, L. V. (1978). PLUMBING INSTALLATION AND DESIGN. Alsip, IL: American Technical Publishers.

McReynolds, Ray (1997) STEP BY STEP GUIDE BOOK ON HOME PLUMBING, Step-By-Step Guide Book Co. Salt Lake City, Utah 1-800-678-1500

RESOURCES:

Black and Decker Home Improvement Library. (1990). HOME PLUMBING PROJECTS & REPAIRS. Available from: Cy DeCosse Inc., 5900 Green Oak Drive, Minnetonka, Minnesota 55343 1-800-328-3895

Special Materials and Equipment:

Examples or a chart of different types of fittings, examples of different plumbing tools. Examples of different pipe materials, slides demonstrating installation of each type of material, examples of materials used to make joint connections. All materials necessary to construct a plumbing project of the instructor's choice; project should include steel, plastic, and copper materials.

Evaluation:

Tool Identification test by the instructor and oral review. Completion and testing of project.

Unit Exam

## UNIT EXAM, PLUMBING

Circle the best answer.

1. Which of the following statements is correct?
  - a. A street elbow has one male thread and one female thread.
  - b. A bushing has two female threads.
  - c. A reducer has one male thread and one female thread.
  - d. A 90 degree elbow has two male threads.
2. The most common way to identify size of pipe is by:
  - a. Inside diameter
  - b. Outside diameter
  - c. Wall thickness
  - d. Pressure tolerance
3. The proper sequence for assembling PVC pipe is:
  - a. Prime, cut, glue, assemble
  - b. Cut, prime, assemble, glue
  - c. Cut, prime, glue, assemble
  - d. Cut, sand, glue, assemble
4. Soft 50-50 solder is a combination of:
  - a. Tin and lead
  - b. Tin and zinc
  - c. Gold and zinc
  - d. Silver and zinc
5. What type of threads are found on steel pipe fittings?
  - a. Straight pipe threads
  - b. Straight machine threads
  - c. Hose threads
  - d. Tapered pipe threads
6. A valve used for water supply systems to prevent backflow of water is the:
  - a. Gate valve
  - b. Globe valve
  - c. Check valve
  - d. Cock valve

7. Which pipe fitting would be used to fasten the ends of pipes where neither pipe can be turned?
- a. Coupling
  - b. Reducer
  - c. Bushing
  - d. Union
8. Soldering flux is not essential when sweat soldering copper pipe.
- a. True
  - b. False
9. When threading steel pipe, the pipe should extend beyond the die at least 1/2 inch.
- a. True
  - b. False
10. The standard length for steel pipe is:
- a. 10 feet
  - b. 12 feet
  - c. 15 feet
  - d. 20 feet
  - e. 21 feet
11. Bushing pipe fittings have:
- a. One male thread and one female thread
  - b. Two male threads
  - c. Two female threads
12. During the soldering process, the solder is distributed between surfaces of the bare metals by:
- a. Capillary action
  - b. Caterpillar action
  - c. Pressure
  - d. Osmosis
13. PVC stand for:
- a. Partial Value Code
  - b. Poly Vinyl Chloride
  - c. Poly Value Chloride
  - d. Partial Vinyl Chloride

14. Copper tubing can be joined by which of the following methods?
- a. Flare fittings
  - b. Sweating
  - c. Solvent welding
  - d. Both a and b
  - e. Both a and c
15. Steel pipe and copper pipe or tubing should never be connected directly together because of:
- a. Electrolysis
  - b. Hydration
  - c. Hydrolysis
  - d. Hydrocorrosion
16. Copper pipe is specified by its:
- a. Nominal outside diameter
  - b. Actual outside diameter
  - c. Nominal inside diameter
  - d. Actual inside diameter
17. Suppose a pump is to be removed from a plumbing system. Which of the following fittings allows the pump to be removed without disassembling the entire system?
- a. Adapter
  - b. Union
  - c. Bushing
  - d. Coupling
18. Drain-Waste-Vent (DWV) plumbing systems may be constructed with which of the following materials? (More than one answer can be circled)
- a. Copper
  - b. ABS
  - c. Cast Iron
  - d. Clay
19. Which of the materials listed below are used to assure a leakproof joint on tapered pipe threads? (More than one answer can be circled.)
- a. Teflon tape
  - b. PVC glue
  - c. Pipe joint compound with virgin teflon
  - d. Pipe dope

20. The primer used on PVC is to soften the plastic so the glue welds the two joints together stronger.

- a. True
- b. False

21. Which of the following materials can be used for natural gas lines?

- a. Galvanized steel
- b. Copper
- c. ABS
- d. Black steel

22. Galvanized steel pipe can be used only for cold water systems.

- a. True
- b. False

23. All three types of plastic pipe can be joined to plastic fittings by means of a special solvent cement (glue).

- a. True
- b. False

24. Plastic pipe can be cut with which of the following tools:

- a. Plastic pipe cutter
- b. Hacksaw
- c. Backsaw
- d. Tubing cutter
- e. All of the above

25. How many lengths of galvanized steel pipe do you need to order if you had to cut 14 faucet risers which were each 3 foot long? (SHOW ALL YOUR WORK!)

Answer Sheet- Unit Exam

1. A
2. A
3. C
4. A
5. D
6. C
7. A
8. B
9. B
10. E
11. A
12. A
13. B
14. D
15. A
16. C
17. D
18. A,B
19. A,C,D
20. A
21. D
22. B
23. A
24. E
25. 2

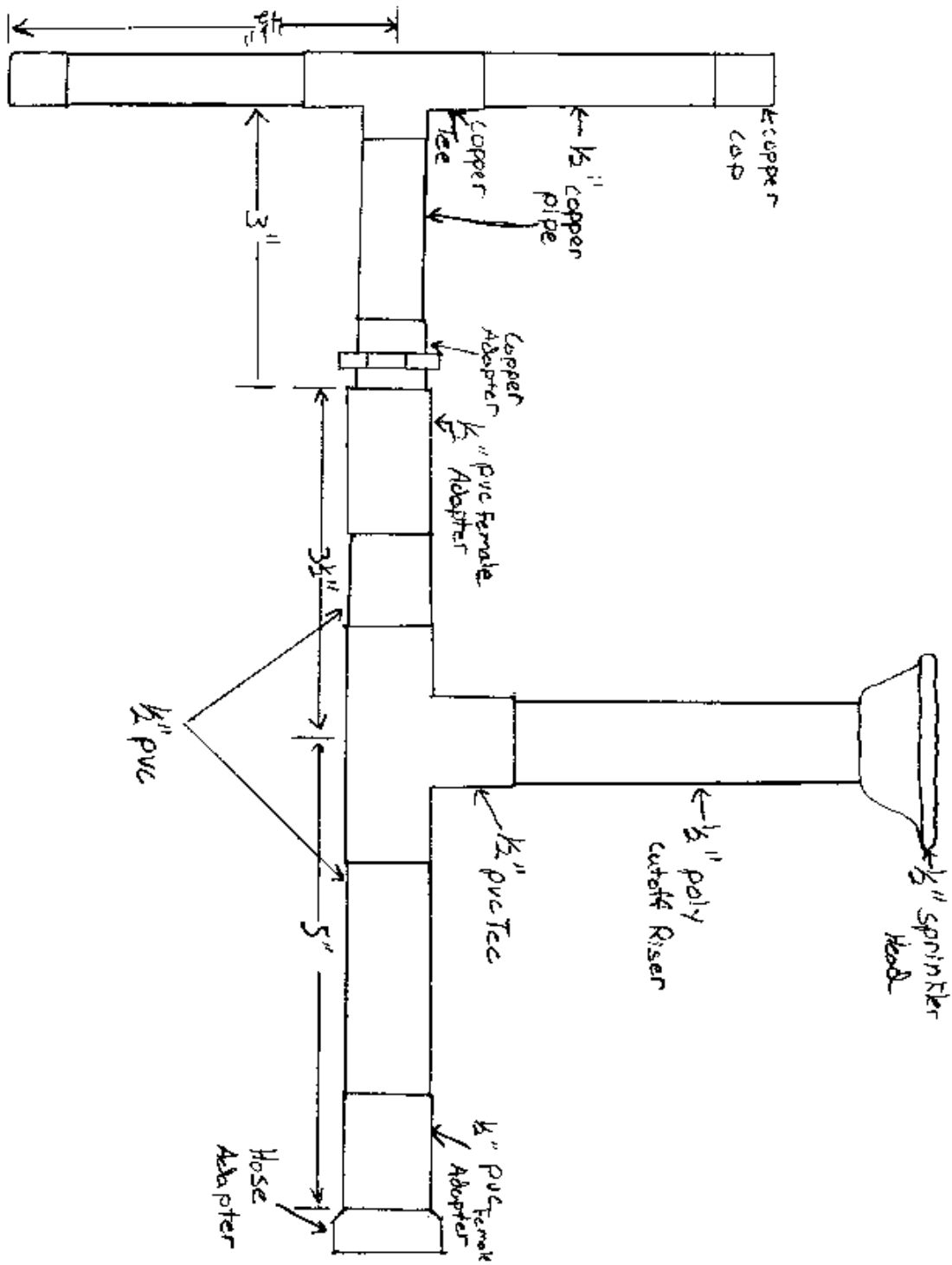
Items Needed for Plumbing Project

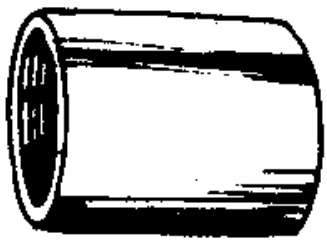
1/2" PVC pipe (12" per project)  
1/2" PVC Tee slip by slip by treaded (1 per project)  
1/2" PVC female adapter, slip by female treaded (1 per project)  
1/2" PVC hose adapter, female (1 per project)  
1/2" Sprinkler Head (1 per project)  
1/2" Poly Cutoff Riser (1 per project)  
1/2" Copper adapter, sweat by male treaded (1 per project)  
1/2" Copper Tubing (12" per project)  
1/2" Copper Cap (2 per project)  
1/2" Copper Tee (1 per project)

Tools Needed

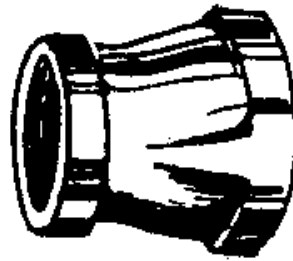
Rosen Core Solder  
Solder Flux  
Steel Wool  
Tubing Cutters  
Butane or Propane Torch  
PVC Pipe Cutters or Hacksaw  
PVC Glue  
PVC Primer



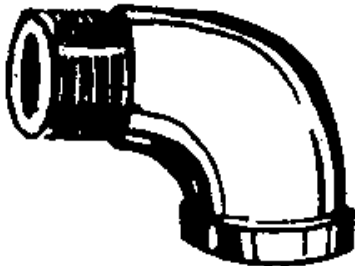




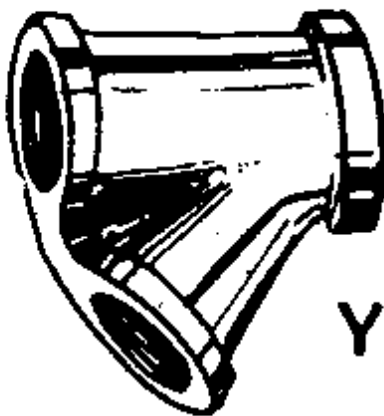
**Coupling**



**Bell Reducer**



**90° Street Elbow**



**Y**



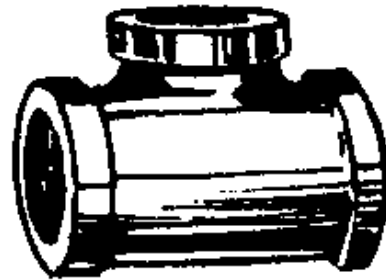
**Nipples**



**Floor Flange**



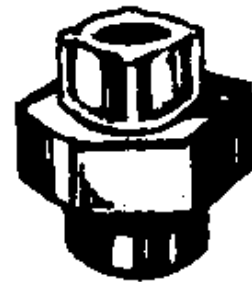
**Plug**



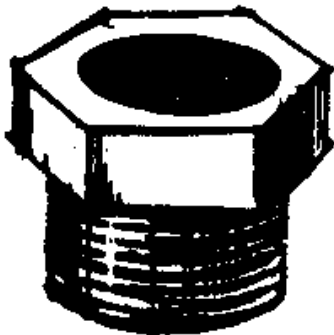
**T**



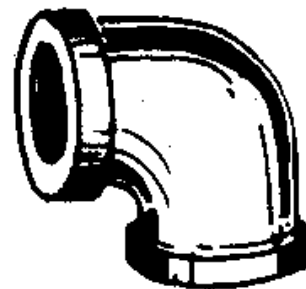
**45° Elbow**



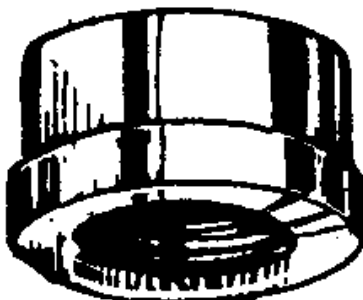
**Union**



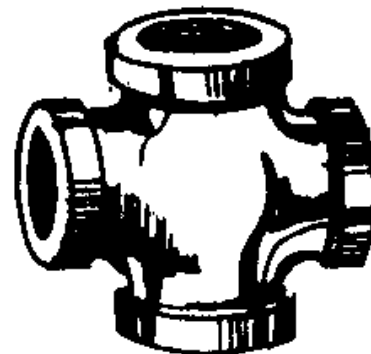
**Bushing**



**90° Elbow**



**Cap**



**Straight Cross**